X. *Observations on the Dip and Variation of the Magnetic Needle, and on the Intensity of the Magnetic Force; made during the late voyage in search of a North West Passage.* *By Captain* Edward Sabine, *of the Royal Regiment of Artillery, F. R. S. and F. L. S.*

Read February 25, 1819.

THE dipping needle used in these observations is the property of HENRY BROWNE, Esq.; it was made by Messrs. NAIRNE and BLUNT, and is similar in construction to one made by the same artists, and described by the Hon. HENRY CAVENDISH in the 66th volume of the Philosophical Transactions, as used in the house of the Royal Society.

Previously to delivering it into my charge, Mr. BROWNE had adjusted the balance of the needle by means of the screws on the cross of wires attached to its axis; so that no alteration took place in the indication of the dip, on reversing the poles.

The instrument was placed in the direction of the magnetic meridian, by a compass stationed at a sufficient distance, and suffered to remain during the observations for the purpose of occasional verification. When time admitted, the correctness of adjustment was also proved, by observing the minimum of dip. An equal number of observations were made with the face of the instrument towards the east and towards the west; the arcs indicated at both ends of the needle were read.

In determining the intensity of the magnetic force, the needle was drawn to an horizontal position by a magnet, and being released at an observed moment of time, was suffered

to oscillate until the arcs became too small to be readily distinguished: the first arc was thus equal to the dip, and at every tenth vibration both the arc and time were noted. The observations in the magnetic meridian were repeated with the face of the instrument towards the east and towards the west.

It is highly satisfactory to notice the agreement of the results which were obtained in London and in Shetland, at different periods, and by different observers; showing that the adjustment of the balance of the needle was preserved during the voyage, notwithstanding the accidents to which it was liable: and as a testimony of the excellence of the instrument, and of the confidence which may be placed in observations made with it.

Observations on the dip.

1818.	Latitude.	Longitude.	No. of obser.	Observer.	Dip.	Remarks.
	° ′	° ′			° ′ ″	
April 13	51 31 N.	0 08 W.	16	Capt. Kater	70 34 39	Regent's Park, London.
30	60 09½	1 12	14	Capt. Sabine	74 22 48	Brassa Island, Shetland.
May 1	60 09½	1 12	12	Lieut. Parry	74 20 10	
June 9	68 22	53 50	12	Capt. Sabine	*83 08 07	On ice.
19	70 26	54 52	14	Capt. Sabine	*82 48 47	Hare Island.
July 8	74 04	57 52	10	Capt. Sabine	84 09 15	(Baffins) three Islands.
23	75 05	60 03	10	Lieut. Parry	84 24 57	On ice.
23	75 05	60 03	10	Capt. Sabine	84 25 15	
Aug. 2	75 51½	63 06	10	Capt. Sabine	84 44 30	On ice.
4	75 59	64 47	10	Capt. Sabine	84 52 06	On ice.
19	76 32	73 45	10	Capt. Sabine	85 44 23	On ice.
20	76 45	76 00	14	Lieut. Parry	86 08 53	On ice.
20	76 45	76 00	14	Capt. Sabine	86 09 33	
25	76 08	78 29	16	Capt. Sabine	85 59 31	On ice.
Sept. 11	70 35	66 55	10	Capt. Sabine	84 39 21	On ice.
Nov. 3	60 09½	1 12		Lieut. Parry	74 21 06	Brassa Island, Shetland.
3	60 09½	1 12	14	Capt. Sabine	74 21 47 15	
1819.						
March	51 31	0 08	16	Capt. Sabine	70 33 16	Regent's Park, London.

It is probable that the needle was affected by local attraction either on the 9th or on the 19th of June; but on which day it is difficult to say. On the 9th the ships were anchored to an iceberg of very considerable size, on which the observations were made, the instrument being removed as far as possible from the ships. On the 19th it was used in the observatory which was erected on Hare Island; every fastening of this ingenious and useful building was of brass, and the greatest care was taken to prevent the needle being disturbed by local or accidental causes. But there were several basaltic columns on the face of a hill which rose immediately from the observatory, which may have had an influence; as these columns on Hare Island are said, by Professor GIESECKE,* to have a powerful effect on the needle.

Observations on the intensity of the magnetic force.

Regent's Park, London, April, 1818. *By Captain* KATER.

Perpendicular to the meridian.

100	8 21,6		Account of vibrations.	° ′ 0 0 91 0 59 0 42 0 30 0 21 0 15 0 10 0 6 0 4 0 2 0 1 0
100	8 15			
100	8 18,3	Mean	No. of vibrations.	0 10 20 30 40 50 60 70 80 90 100

The subsequent observations were made by Captain SABINE.

* Art. Greenland, BREWSTER'S Cyclopædia.

Brassa Island, Shetland, lat. 60° 09′, *long.* 1° 12′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibration.	Arc.	Time.
	m. s.				Seconds.
100	7 49,5		0	74°	
100	7 50		10	53	50
			20	40	48.5
			30	30	47
			40	22	46
			50	16	46
			60	12	46
			70	7	47
			80	5	47
			90	2	46
100	7 49,75	Mean	100	1	46

Perpendicular to the meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	8 00		0	90°	
100	7 59		10	57	52
			20	42	49
			30	32	47
			40	24	48
			50	18	48
			60	13	47
			70	9	47
			80	5	47
			90	3	47.5
100	7 59,5	Mean	100	1	47.5

On an iceberg in Davis's Strait, lat. 68° 22′, *long.* 53° 50′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 17		0	83°	
100	7 23		10	59	48
			20	45	45
			30	35	45
			40	27	43
			50	21	44
			60	16	43
			70	12	44
			80	9	43
			90	7	44
100	7 20	Mean	100	4	44

Perpendicular to the meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 33		0	90°	
			10	60	47
			20	46	46
			30	35	45
			40	27	45
			50	21	42
			60	16	45
			70	12	44
			80	8	51
			90	6	44
			100	4	44

On Hare Island, lat. 70° 26′, *long.* 54° 52′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 22		0	83°	48
100	7 24		10	59	45
100	7 21	Mean	20	46	45
			30	36	44
			40	27	44
			50	21	44
			60	16	44
			70	12	43
			80	9	45
			90	6	43
			100	4	43

Perpendicular to the meridian.

Number of vibrations.	Interval.	No. of vibrations.	Arc.	Time.
	m. s.			Seconds.
100	7 26	0	90°	48
		10	62	46
		20	47	45
		30	37	44
		40	28	44
		50	22	44
		60	17	44
		70	13	43
		80	9	45
		90	7	43
		100	5	44

On ice in Baffin's Bay, lat. 75° 05′, *long.* 60° 23′.

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 29		0	84⅔°	47·5
100	7 25·5		10	59	45·5
100	7 27·5	Mean	20	45	44·5
			30	35	44·5
			40	26	44·5
			50	19	44
			60	14	43
			70	10	44·5
			80	7	45
			90	4	44
			100	1	43

Perpendicular to the meridian.

Number of vibrations.	Interval.	No. of vibrations.	Arc.	Time.
	m. s.			Seconds.
100	7 26	0	90°	48
		10	61	46
		20	46	46
		30	36	44·5
		40	28	44
		50	21	44·5
		60	16	43
		70	12	43·5
		80	9	43·5
		90	6	44
		100	4	45

On ice in Baffin's Bay, lat 75° 51½′, *long.* 63° 06′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		Time.	Arc.	No. of vibrations.
	m. s.		Seconds.		
100	7 21,5		48	84°	0
100	7 25		45	58	10
			44,5	46	20
100	7 23,25	Mean	44,5	35	30
			43,5	28	40
			43,5	22	50
			44	17	60
			43,5	13	70
			44,5	10	80
			44	7	90
				5	100

Perpendicular to the meridian.

Number of vibrations.	Interval.		Time.	Arc.	No. of vibrations.
					0
					10
					20
					30
					40
					50
					60
					70
					80
					90
					100

On ice in Baffin's Bay, lat. 76° 45′, *long.* 76° *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		Time.	Arc.	No. of vibrations.
	m. s.		Seconds.		
100	7 13		47	86°	0
100	7 17		45	60	10
			44	46	20
100	7 15	Mean	43	36	30
			43	28	40
			43	22	50
			43	18	60
			42	13	70
			44	10	80
			43	7½	90
			43	5	100

Perpendicular to the meridian.

Number of vibrations.	Interval.		Time.	Arc.	No. of vibrations.
	m. s.		Seconds.		
100	7 16		44	90°	0
			44	45	10
			44	35	20
			43	27	30
			43	21	40
			43	17	50
			43	13	60
			44	9½	70
			43	7	80
			44	5	90
			44	3½	100

On ice in Baffin's Bay, lat. 76° 08½′, *long.* 78° 21′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 15		0	85°	45
100	7 17		10	51	44,5
			20	40	43,5
			30	31	44
			40	24	43
			50	19	43
			60	14	43
			70	11	43
			80	8	42
			90	6	42,5
100	7 16	Mean	100	4	44,5

Perpendicular to the meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 18		0	90°	46,5
			10	57	45
			20	45	44,5
			30	35	42,5
			40	27	43,5
			50	21	43,5
			60	17	43,5
			70	13	43,5
			80	10	43
			90	7	43,5
			100	5	42,5

On an iceberg in Davis's Straits, lat. 70° 35′, *long.* 66° 55′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 16		0	85°	46
100	7 16		10	47	44
			20	36	44
			30	28	44
			40	21	44
			50	17	43
			60	12	43
			70	9	43,5
			80	6	43,5
			90	4	43
100	7 16	Mean	100	2	42

Perpendicular to the meridian.

Number of vibrations.	Interval.		No. of vibrations.	Arc.	Time.
	m. s.				Seconds.
100	7 18,5		0	90°	46
			10	60	45,5
			20	47	44
			30	37	44,5
			40	30	43,5
			50	23	43,5
			60	19	43,5
			70	15	43,5
			80	12	43,5
			90	9	43
			100	7	41,5

1819, *March. In the Regent's Park, London, lat.* 51° 31′ 40″, *long.* 0° 08′ *W.*

In the magnetic meridian.

Number of vibrations.	Interval.		No of vibrations.	Arc	Time.
	m. s.				Seconds.
100	8 01,5		0	71°	50
100	8 08		10	55	49
100	7 56,5		20	40	48
100	8 02	Mean	30	30	49
			40	23	48
			50	17	47
			60	13	48
			70	9	48,5
			80	6	47
			90	3	47
			100	1	

Perpendicular to the meridian.

Number of vibrations.	Interval.	No. of vibrations.	Arc.	Time.
	m. s.			Seconds.
100	8 18,5	0	90°	52
		10	55	52
		20	40	49,5
		30	30	49,5
		40	22	49
		50	16	48,5
		60	11	49,5
		70	7	48,5
		80	4	50,5
		90	2	49,5
		100	1	

Abstract of the times in which 100 *vibrations were performed.*

Latitude. N.	Longitude. W.	In the meridian.	First Arc.	Perpendicular to the meridian.	First Arc.	
° ′	° ′	m. s.		m. s.	°	
51 31	0 08	0 0	0	8 18,3	90	Regent's Park, London.
60 09	1 12	7 49¾	74	7 59,5	90	Shetland.
68 22	53 50	7 20	83	7 33	90	On ice, Davis's Straits.
70 26	54 52	7 21	83	7 26	90	Hare Island.
75 05	60 23	7 27½	84	7 26	90	On ice, Baffin's Bay.
75 51½	63 06	7 23¼	84	0 0	—	On ice, Baffin's Bay.
76 45	76 00	7 15	85	7 26	90	On ice, Baffin's Bay.
76 08	78 21	7 16	85	7 18	90	On ice, Baffin's Bay.
70 35	66 55	7 16	83	7 18,5	90	On ice, Davis's Straits.
51 31	0 08	8 02	70	8 18	90	Regent's Park, London.

The 100th vibration never exceeded an arc of 3°

Observations to determine the variation of the needle, in Davis's Strait, and Baffin's Bay.

The azimuth compasses used in these observations were constructed on an improved plan, the invention of Captain KATER. It is thus described in the "Instructions for the use of the Instruments furnished to the Northern Expeditions," printed by order of the Royal Society:

"The compass is five inches diameter; by means of an inclined mirror and lenses, the degrees are seen by reflection considerably magnified; a line drawn on a piece of ivory is viewed at the same time, and serves as an index by which the degrees are to be read off.

"At the opposite side of the box is a sight on which slides, in a frame, the segment of a glass cylinder, ground to a radius of five inches. By means of this, a fine line of light is thrown on the index, and may be seen at the same time as the degrees on the card.

"The degrees on the card are read from the north towards the east, and are carried round to 360°, in order to obviate the possibility of error in this respect."

The observations were made either on shore or on the ice, sufficiently distant from the ship to be beyond the influence of her attraction. The compass was placed on a copper fastened stool, and was carefully levelled by means of a spirit level, to ensure the perpendicularity of the sight vane.

Each altitude and azimuth is a mean of several observations, the compass being removed and levelled afresh between every one, thus making each faithfully distinct.

The mean Greenwich time is given, as it determines the amount of the sun's polar distance.

The latitudes and longitudes are of the spot, deduced by the ship's log from the nearest observed.

The altitudes are corrected for index error only, the letters or signs annexed denote the limb, and whether by reflection or by the natural horizon.

The observed azimuths are of the sun's centre cleared of index error; the compasses used were No. 1 and 2, supplied to the Isabella, and No. 3 to the Alexander; the true azimuths deduced from the elements contained in the preceding columns, are expressed in a corresponding manner to the reading of the compass, for the purpose of comparison.

The observations were made on ice, except when otherwise noted in the column of remarks.

When due consideration is given to the greatly diminished power, with which the earth's magnetism acts on the horizontal direction of the needle, when the dip becomes so considerable as it was found in Davis's Straits and Baffin's Bay, namely, from 83° to 86°; the satisfactory results which have been obtained, even under such extreme circumstances with Captain KATER'S compasses, afford the best testimony of their excellence, and of the precision which may be expected from them in the ordinary course of observation.

It may also be remarked, that a difference in the result of azimuths observed at different hours of the day may not be altogether an error of observation, since it is probable that as the directive power of magnetism diminished, the causes which produce the hourly change in the variation itself may act with increased effect.

Should the amount of this change be considerably augmented in high magnetic latitudes, careful observations on the direction of the needle at different hours of the day, on all convenient occasions, might be serviceable towards a more certain knowledge of its causes, than has been hitherto obtained from observations made where the effects are so inconsiderable.

The influence of the ship's iron on their compasses increasing, as the directive power of magnetism diminished, produced irregularities that rendered observations on board ship of little or no value towards a knowledge of the true variation; a few azimuths which were observed in the Isabella, have been selected for the purpose of exemplifying this remark. They will also show, how essential it is to navigation in high latitudes, that the nature of the errors which the ship's attraction produces in her compasses, should be understood.

Observations to determine the variation of the needle, made on shore, or on the ice. Observer, Captain SABINE.

1818.	Mean Greenwich time. h.	m.	s.	Latitude. °	′	Longitude. °	′	Observed Altitude. °	′	″		Observed azimuth. °	′	Compass.	True azimuth. °	′	VARIATION. °	′	Remarks.
June 9	22	0	0	68	23¼ N.	53	47 W.	48	23	15	☉	156	27	1	88	55½	67	31½ W.	
11	23	20	0	68	14	54	15	63	20	58	☉	175	47	2	108	07	67	40	
12	0	0	0	68	14	54	15	70	02	33	☉	186	16	1	118	12	68	04	
17	8	20	0	70	26¼	54	52	56	15	36	☉	332	54	1	260	08	72	46	
17	8	30	0	70	26¼	54	52	55	32	34	☉	334	05	1	261	11½	72	53½	
18	8	28	0	70	26¼	54	52	55	20	52	☉	332	52	1	261	33	71	19	Observatory, Hare Island.
18	8	35	0	70	26¼	54	52	55	33	45	☉	334	24	1	263	10½	71	13½	
								53	57	35	☉								
18	23	20	0	70	26¼	54	52	64	43	18	☉	184	35	1	112	55½	71	39½	
27	9	00	00	71	02½	54	13	50	18	13	☉	343	26⅔	1	268	13⅔	75	13	
27	9	20	00	71	02½	54	13	49	18	20	☉	346	33⅔	1	271	13	75	20⅔	
27	9	40	00	71	02½	54	13	47	07	0	☉	349	54⅓	1	274	23	75	31	
27	10	00	00	71	02½	54	13	44	36	40	☉	353	35	1	278	0	75	35	
27	10	20	00	71	02½	54	13	42	07	17	☉	357	24⅓	1	281	36⅓	75	48	
July 4	10	45	00	72	44½	56	49	37	18	47	☉	7	13⅔	1	288	18⅔	78	55	
6	9	12	0	73	22½	57	32	49	10	00	☉	348	16	1	268	15	80	01	
12	23	30	0	74	01⅓	57	52	55	11	52	☉	186	49⅓	1	106	05⅔	80	43⅔	On Baffin's three Islands.
21	10	05	0	74	58	59	16	38	49	57	☉	0	33½	1	276	00½	84	33	
22	23	02	0	75	04	60	03	45	46	0	☉	185	16	1	98	16½	86	59½	
28	10	20	0	75	28	60	34½	35	04	10	☉	7	40	1	279	21⅓	88	18⅔	
30	8	17	0	75	32	61	0	48	23	57	☉	336	24⅓	1	248	46⅔	87	37⅓	
30	10	20	0	75	32	61	0	36	29	35	☉	0	55⅓	1	272	41⅔	88	13⅔	
Aug. 2	10	00	00	75	44½	64	0	17	33	15	L.	2	26	1	273	25	89	01	
2	10	10	00	75	44½	64	0	17	01	25	L.	4	31	1	275	37⅓	88	53⅓	
4	0	12	30	75	59	64	32	46	39	55	☉	204	01	1	113	43⅓	90	17⅔	
6	9	34	0	70	50½	64	34	37	27	20	☉	354	24	1	263	16⅓	91	07⅔	
12	0	00	51	75	54½	65	30	40	19	34	☉	202	31⅓	1	109	45⅔	92	45⅔	
12	0	12	51	75	54½	65	30	40	59	55	☉	205	24⅔	2	110	50⅓	94	34⅓	
12	0	29	30	75	54½	65	30	43	36	28	☉	210	52⅓	1 & 2	117	12⅔	93	39⅔	
19	2	13	00	76	30	72	35	45	59	50	☉	240	32	1 & 2	138	23	102	09	
19	2	33	00	76	30	72	35	47	27	10	☉	246	53½	2	143	37½	103	16	Compasses used alternately.
19	2	33	00	76	30	72	35	47	33	40	☉	245	58½	1	144	03½	101	55	
22	9	00	00	76	32⅔	76	52½	36	54	40	☉	348	56	1	241	00	107	56	
25	8	27	10	76	08⅔	78	21	40	32	30	☉	341	05½	2	230	07	110	58½	Compasses used alternately.
25	8	27	10	76	08½	78	21	40	14	05	☉	341	17½	1	230	58	110	19½	
25	10	03	00	76	08½	78	21	30	06	47	☉	4	05	1	254	56	109	09	Observed by the silk line, the line of light not being perceptible owing to the weather.
25	10	08	00	76	08½	78	21	28	25	25	☉	5	43½	3	256	18	109	25½	
Sept. 11	8	30	00	70	35½	66	55½	13	27	30	L.	330	44	1 & 2	244	06	86	38	Dip of horizon allowed for 51 feet 7 in. measured.
11	8	36	00	70	35½	66	55½	12	59	47	L.	332	58⅔	2	245	36	87	22⅔	Compasses used alternately.
11	8	40	00	70	35½	66	55½	12	39	33	L.	333	19⅓	1	246	41	86	38⅓	

In the column of "observed altitude," ☉ signifies the lower, and ☉ the upper limb of the sun, the altitude being taken by reflection; L, the lower limb by the natural horizon.

Results of azimuths observed on board the Isabella, with WALKER'S *azimuth compass, placed amidships in front of the companion.*

1818.	Latitude.	Longitude.	Ship's head.	Variation.	Remarks.
	° ′	° ′		° ′	
June 3	65 38	54 24	NW. by W.	67 10	
4	65 47	54 44	N.	66 22	
4	65 47	54 44	W.	77 34	
4	65 46	54 44	E. S. E.	47 54	
5	65 47	54 22	N.W.	76 47	
5	65 47	54 22	N.	67 32	
7	65 50	55 0	NE. by E.	49 57	
27	74 02	54 13	E.	64 56	
27	74 02	54 13	S. E.	67 07	
27	74 02	54 13	S.	76 27	
27	74 02	54 13	S.W.	84 38	True variation observed on the ice 75° 30′.
27	74 02	54 13	W.	93 16	
27	74 02	54 13	N.W.	90 20	
27	74 02	54 13	N.	77 44	
27	74 02	54 13	N. E.	70 30	
Aug. 29	74 44	77 50	W.N.W.	128 35	
30	74 21	78 0	N. by E.	104 28	
Sep. 3	73 55	73 47	N. by W. ½ W.	108 55	
4	73 23	75 58	E. by S. ½ S.	85 04	
5	72 34	74 06	S.E.	74 22	
5	72 34	74 06	S. ¼ W.	90 32	
5	72 34	74 06	S. S. E.	78 50	
11	70 37	66 58	N.W.	98 42	
11	70 37	66 58	N.W. by W.	100 08	True variation observed on the ice 86° 53′.
11	70 37	66 58	W.N.W.	100 56	
11	70 37	66 58	W. by N.	99 36	
16	68 40	64 0	N. by E.	73 56	
16	68 40	64 0	S.E. by E. ½ E.	59 07	
29	64 53	62 10	N.N.W.	71 21	
29	65 02	62 10	S.W.	75 40	
Oct. 14	59 30	36 07	E. S. E.	39 04	
14	59 30	36 07	N.W. by N.	52 55	